NASA SCIENCE MISSION DIRECTORATE

Earth-Sun System Applied Sciences Program
Agricultural Efficiency Program Element
FY 2005-2009 Plan

Version 1.2

March 15, 2005

Expanding and accelerating the realization of economic and societal benefits from Earth-Sun System science, information, and technology

This page intentionally blank.

NASA Science Mission Directorate
Earth-Sun System Division
Applied Sciences Program

Applied Sciences for the Agricultural Efficiency Program Element

This document contains the Agricultural Efficiency Program Element Plan for Fiscal Years 2005-2009. This plan derives from direction established in the NASA Strategic Plan, the Earth Science Enterprise Strategy, the Space Science Enterprise Strategy, the Earth Science Applications Plan, and OMB/OSTP guidance on research and development. The plan aligns with and serves the commitments established in the NASA Integrated Budget and Performance Document.

The Program Manager and the Applied Sciences Program leadership have reviewed the plan and agree that the plan appropriately reflects the goals, objectives, and activities for the program element to serve the Applied Sciences Program, the Earth-Sun System Division, NASA, the administration, and society.

(Signature on file) February 11, 2005
Ed Sheffner Date
Program Manager, Agricultural Efficiency
Applied Sciences Program
NASA Earth-Sun System Division

(Signature on file) February 11, 2005
Lawrence Friedl Date
Lead, National Applications
Applied Sciences Program
NASA Earth-Sun System Division

(Signature on file) February 11, 2005
Ronald J. Birk Date
Director, Applied Sciences Program
NASA Earth-Sun System Division

This page intentionally blank.

NASA Earth-Sun System Division: Applied Sciences Program
Agricultural Efficiency

TABLE OF CONTENTS

NASA Science Mission Directorate – Applied Sciences Program

Agricultural Efficiency Program Element Plan: FY 2005 – 2009

I. Purpose and Scope

This plan describes the Agricultural Efficiency Program Element for Fiscal Years 2005 (FY05) through 2009. Included in the plan are the purpose of the program and the strategy to meet the agricultural efficiency objectives using the resources available. The plan describes the approach of the program element, including NASA's role in partnerships, the focus on decision support tools, and the extension of NASA Earth-Sun system science results to meet the decision support requirements of partner agencies and organizations. Within the Earth-Sun System Division, this plan functions as a program management tool, describing the program structure, functional mechanisms, performance measures, and general principles that the agricultural efficiency activity will follow. The plan includes projects in which Earth-Sun system science results can be applied to decision making with related socioeconomic benefits.

Information on vegetation condition derived from remote sensing has long been used in decisions concerning agricultural production. Collaborations among the National Aeronautics and Space Administration (NASA), the National Oceanic and Atmospheric Administration (NOAA) and the U.S. Department of Agriculture (USDA) in the 1970's and 1980's (e.g., the Large Area Crop Inventory Experiment (LACIE), and Agriculture and Resources Inventory Surveys Through Aerospace Remote Sensing (AgRISTARS)) demonstrated that observations and measurements from Earth observing spacecraft provide valuable information on crop production, yield, and condition. The technology and methodology that emerged from those programs formed, for example, the foundation for much of the global and domestic crop assessment work USDA conducts through the Foreign Agriculture Service (FAS) and the National Agricultural Statistics Service (NASS). FAS and NASS assessments are utilized by policy makers, agribusiness resource managers, and producers to make decisions on agricultural management including planting, harvesting, marketing, commodity export and pricing, drought monitoring, and food assistance.

USDA administers a number of production, conservation, and environmental programs for American farmers regarding the sustainability of domestic agricultural production. Through USDA agencies such as the Farm Service Agency (FSA), the Natural Resource Conservation Service (NRCS), the Risk Management Agency (RMA), and others, programs are implemented and managed that enable the American agricultural producer to manage the perils associated with nature and markets while conserving, maintaining, and improving America's natural resources and environment. Management of many of these farmer-focused programs requires timely and accurate information on crop condition and weather--and longer-term climate predictions--that can be derived from existing and planned NASA Earth-Sun science missions and models.

The current generation of NASA Earth-Sun System observations (Terra, Aqua, TRMM) and models provide opportunities for the agricultural community to predict and monitor global and domestic agricultural production and yield - assessments that help to drive the U.S. agricultural industry. In the next decade, NASA will launch a number of new Earth science missions to

provide new sources of observations and measurements to address NASA's Applied Sciences mission. The observations and measurements from the new missions, (e.g., the Orbiting Carbon Observatory (OCO), Aquarius and the Hydrosphere State Mission (Hydros)) may also provide improvements to the decision support systems and tools employed by USDA and other organizations with mandates to monitor agricultural efficiency.

Scope within NASA and Applied Sciences Program

The Agricultural Efficiency Program Element is managed in accordance with, and is guided by, the NASA Strategic Plan and Earth Science Enterprise Strategy. The program element benefits from Earth-Sun system science results and capabilities including Operation System Simulation Experiments (OSSEs), Project Columbia, the Joint Center for Satellite Data Assimilation (JCSDA), the Earth-Sun System Gateway (ESG), and the Transition from Research to Operations (R2O). The program element utilizes initiatives such as the Global Information Grid (GIG) and Federal Enterprise Architecture (FEA) and cooperates with national Earth-Sun laboratories and international programs.

The FY05 President's Budget for the NASA Applied Sciences Program* specifies $54M annually for FY05-FY09 for the National Applications ($24M) and Crosscutting Solutions ($30M) activities. While directly managing a subset of the $24M National Applications budget, the Agricultural Efficiency Program Element (and each of the national applications) benefits from the performance results of the $30M budget for Crosscutting Solutions (see Crosscutting Solutions Program Element Plan). The Agricultural Efficiency Program Element leverages and extends research results from the approximately $2.1B per year supporting Earth-Sun system science research and development of innovative aerospace science and technology.

Additional information about the NASA Applied Sciences Program can be found at http://science.hq.nasa.gov/earth-sun/applications.

** The National Applications and Crosscutting Solutions components of the Earth Science Applications Theme in the NASA FY05 Integrated Budget & Performance Document*

The Agricultural Efficiency Program Element focuses on enhancing the ability of NASA's partners to predict production and yield. This program plan addresses such predictions primarily through integration of NASA capabilities, especially data and modeling capabilities in weather, climate, and natural hazards, into the global and domestic production and yield forecasting mandates of USDA. NASA is collaborating with the Foreign Agricultural Service (FAS) to improve the timeliness and accuracy of the information and predictions the FAS supplies to the World Agricultural Outlook Board (WAOB) in the board's monthly review of global agriculture. The inputs from FAS have an impact in the billions of dollars on agriculture decisions at all levels of agriculture – from individual operators to agribusiness and national agricultural policy and management. The collaboration between NASA and FAS is illustrative of the integrated system solutions that the Applied Sciences Program seeks with its partners (see Appendix A).

USDA and NASA's Earth-Sun System Division are partners in a number of program elements that affect USDA mandates. The partnership is formally recognized in a Memorandum of Understanding (MOU) between NASA and USDA signed in May 2003. An interagency working group, authorized under the MOU, is meeting regularly to define collaborative projects in Agricultural Efficiency and other Earth-Sun System Division Applied Sciences Program Elements, including Carbon Management, Invasive Species, Air Quality, Water Management, Disaster Management, and Homeland Security. When identifying collaborative projects between USDA and NASA in Agricultural Efficiency, the requirements and contributions from the other program elements are considered by the interagency working group to ensure efficiency and prevent duplication of effort.

II. Goals and Objectives

The Applied Sciences Program Agricultural Efficiency Element addresses objectives 1.1, 1.2 and 3.3 of the NASA 2003 Strategic Plan and the NASA Integrated Budget and Performance Document (IBPD) performance measures 5ESA8 and 5ESA9 (see Table 1).

A. Goals: FY05-09:

The long-term goal of the Agricultural Efficiency Program Element is to extend data, modeling and systems engineering capabilities from the Earth-Sun System Division into the decision support systems of USDA and other organizations for global and domestic production and yield estimates. It is expected that NASA capabilities in climate and weather and natural hazards prediction will be key in this effort.

B. Objectives FY05:

1. FAS: Goddard Space Flight Center (GSFC) Project
    a. Modify MODIS-based, 16-day crop condition assessment product and TRMM-based, Surface Moisture Index product (SMI) for evaluation by FAS, USDA/NASS and WFP.
    b. Assist in benchmarking MODIS 16-day product in FAS/PECAD system.
    c. Adapt the GES DAACs TRMM Online Visualization and Analysis System (TOVAS) to provide NASA Earth-Sun observations to users including FAS and WFP.
    d. Extend use of the Agricultural Information System (AIS) to the general user community.
    e. Make NASA data products of interest internet-accessible from the AIS and integrated into the crop monitoring systems of FAS and WFP and in compliance with community-based interoperability standards.
2. FAS: University of Maryland
    a. Rapid Response MODIS data: Produce alternative band combination products, including Vegetation Indices (VI) for Rapid Response subsets. Test compositing methods for Rapid Response data. Add new regions for FAS analysis.
    b. Assist in benchmarking Rapid Response product in FAS/PECAD system.
    c. MODIS standard products: Test inclusion of other MODIS data streams with the interface (EVI, NBARS, etc.), including individual bands. Begin ingest of

AVHRR and SPOT records. Add more geographic regions of interest for analysis. Consider needs for transitioning for VIIRS implementation.

d. Multi-sensor integration - Continue normalization of VI's from all instruments using one reference to allow for standard time series anomaly calculations. The development of ingest systems to process NOAA-18 data for continuity of the AVHRR time series.
e. Value-added products - Complete crop mask based on five years of inputs in order to account for inter-annual variability of crop cover. Start work on prototype development of Vegetation Moisture Stress Index using combination of VI and Land Surface Temperature (LST) data from the Rapid Response System.
f. Database management system - Add aggressive image and data caching techniques to improve system responsiveness. Add usability enhancements such as saving user search parameters/region browser default page/downloadable graph data/enhanced image zoom capabilities. Plan support for VIIRS.

3. Mississippi State University/GRI
   a. Improve accuracy of processes affected by environment in crop models.
   b. Study climate change impacts and drive crop models using remotely sensed environmental variables.
   c. Delineate the effect of climate changes on crops more accurately.
   d. Provide economic assessment of climate change impact on agriculture.
4. USAID/NASA-Goddard Institute for Space Studies (GISS)
   a. Complete preliminary tasks for new project that integrates NASA global and regional climate models and data sets (TRMM and MODIS) into regional decision support system for agricultural management.
   b. Initiate formal work on the task pending review and award to solicited proposal.

C. Objectives: FY06:

1) Benchmark Earth-Sun sciences products in FAS DSS
2) Begin evaluation of the impact of OCO, Aquarius and HYDROS data products on USDA systems, including verification and validation of products.
3) Continue enhancement of regional decision support tool – with USAID.

Table 1: Linkage among objectives from the NASA 2003 Strategic Plan, the IBPD and the Agricultural Efficiency Element Plan

NASA Strategic Plan 2003	Objective	FY05 Agricultural Efficiency Objective
1.1	Understand how the Earth is changing, better predict change, and understand the consequences for life on earth.	3
1.2	Expand and accelerate the realization of economic and societal benefits from Earth science, information and technology	1,2,3,4
3.3	Improve the Nation's economic strength and quality of life by facilitating the innovative use of NASA technology	1,2
IBPD FY05		
5ESA8	V&V solutions for > 5 DSS associated REASoN projects.	1
5ESA9	Benchmark the use of predictions from 2 NASA Earth-Sun system science models for use in national priorities such as support for the CCSP and CCTP.	2

III. Program Management and Partners

Program Management

Program Manager Agricultural Efficiency Program Element

Ed Sheffner
Applied Sciences Program
Science Mission Directorate
NASA Headquarters
Responsibilities:

- Development of and implementation of interagency agreements and partnerships with other organizations
- Program development including program plans and budgets
- Development and implementation of solicitations for Agricultural Efficiency tasks
- Primary responsibility for metrics, performance goals and other performance evaluation criteria
- Liaison to the Research Program in Earth–Sun System Division; North American Carbon Program (NACP); Climate Change Science Program (CCSP) and Climate Change Technology Program (CCTP).

Deputy Program Manager Agricultural Efficiency Program Element
Rodney McKellip
Project Research Scientist
Applied Sciences Directorate
NASA Stennis Space Center (SSC)
Responsibilities:

- Management of Agricultural Efficiency tasks assigned to Stennis Space Center
- COTR or Studies Manager (as appropriate) for grants and cooperative agreements that address Agricultural Efficiency management and are funded through procurement at Stennis Space Center.
- Coordinator and liaison with Program element management for Agricultural Efficiency tasks at NASA centers.

Partners

The Applied Sciences Program pursues partnerships with federal agencies and others that oversee land management decisions and policies that effect agricultural production and yield. The program includes, for technical support, NASA field centers; universities; non-government organizations and commercial entities; and local, state, and tribal organizations that implement agricultural efficiency policies through decision support systems and tools.

The Program is a node in a network involved in Agricultural Efficiency. The network is improving knowledge of Agricultural Efficiency in new environments and is developing and implementing information sources to provide managers and policy makers with the knowledge to allocate resources. Key nodes in the network and currently involved with the program element include:

NASA field centers:
- John C. Stennis Space Center……. Mr. Rodney McKellip et al
- Goddard Space Flight Center……. Dr. Steven Kempler et al
- Goddard Institute of Space Studies…… Dr. Cynthia Rosenzweig et al

Federal partners:
- USDA/FAS……. Dr. Glenn Bethel
- USDA/FAS……. Dr. Brad Doorn
- USDA/Agricultural Research Service……. Dr. Al Dedrick
- USDA/World Agricultural Resources Board…….. Dr. Gerry Bange
- USDA/National Agricultural Statistics Service…….. Dr. Roberta Pense
- USDA/Cooperative State Research, Education and Extension Service ……. Dr. Ray Knighton
- Department of State……. Mr. Fernando Echavarria

Universities:
- Louisiana State University…….. Dr. R. Leonard
- Mississippi State University..... Dr. David Shaw
- Oklahoma State University..... Dr. J. Solie
- University of Arizona..... Dr. Charles Hutchinson
- University of Maryland..... Dr. Chris Justice
- ..... Dr. John Townshend
- University of Missouri..... Dr. Verne Kaupp
- Utah State University……Dr. Phil Rasmussen

Other organizations:
- Institute for Technology Development…… Dr. George May
- Synergy/Raytheon…….Dr. Peter Gilruth

IV. Decision Support Tools and Agricultural Efficiency

Priority Decision Support Tools: FY05-06

PECAD/CADRE

PECAD/CADRE is the term that references the decision support tools and system employed by the Foreign Agricultural Service of the USDA to generate production and yield estimates of major, global agricultural commodities. Estimates from FAS are based on a combination of data sources including information on vegetation condition and water availability derived from data products generated from Earth observing satellites. The estimates from FAS are one source of information used by the World Agricultural Outlook Board when the board issues its official, monthly estimates of production and yield. The economic importance of the WAOB estimates is enormous.

The collaboration between the Applied Sciences Program and USDA on the PECAD/CADRE decision support system began in FY03. A "baseline" report on the DSS was delivered to FAS early in FY04. MODIS products for evaluation by FAS analysts began flowing to FAS in the summer of 2003. Benchmarking of the improvements in the DSS from the initial MODIS products evaluated by FAS is expected by the end of FY05.

NASA and USDA, under the terms of the MOU described in Section I, are exploring new collaborative projects. It is expected that at least one new DSS will emerge from that collaboration and will be base-lined by the end of FY05.

ICASA

The International Consortium for Agricultural Systems Applications (ICASA) provides information to countries in Central and South America on agricultural production. NASA, through the Goddard Institute of Space Studies, proposes to enhance the ICASA decision support system through the incorporation of GISS global and regional climate models (GISS RCM and GISS MM5) supplemented by observational spacecraft observations of vegetation condition and precipitation. NASA's partners in the enhancement of this DSS include USAID, the *Instituto Nacional de Investigacion Agropecuaria* in Uruguay, Florida State University and Mississippi State University.

V. Application Activities

A. Projects

The agricultural efficiency program element authorizes peer-reviewed projects to support the program's goal and objectives. The respective project teams are responsible for developing project plans and managing the activities. The project plans specify the Earth-Sun observations, models, and other outputs to extend to decision support tools as well as the activities to produce appropriate deliverables; the plans integrate contributions from appropriate NASA Centers.

Projects will likely use observations from sensors on: Aura, Terra, Aqua, TRMM, NPP, NPOESS, Hydros, Topex, Jason, OCO and Aquarius. FY05 budget figures presented are for procurement dollars; FY06 and beyond figures are full cost.

<table>
<tr><td colspan="4">Project: University of Maryland Enhancement of FAS DSS</td></tr>
<tr><td colspan="3">The goal of this project is to enhance the decision support capabilities of the Foreign Agricultural Service in USDA through the integration of NASA MODIS products into the PECAD/CADRE decision support system.

FY05 – 1) Rapid Response MODIS data: Produce alternative band combination products, including VI's for Rapid Response subsets. Test compositing methods for Rapid Response data. Add new regions for FAS analysis. 2) Assist in benchmarking Rapid Response product in FAS/PECAD system. 3) MODIS standard products: Test inclusion of other MODIS data streams with the interface (EVI, NBARS, etc.), including individual bands. Begin ingest of AVHRR and SPOT records. Add more geographic regions of interest for analysis. Consider needs for transitioning for VIIRS implementation. 4) Multi-sensor integration - Continue normalization of VI's from all instruments using one reference to allow for standard time series anomaly calculations. The development of ingest systems to process NOAA-18 data for continuity of the AVHRR time series. 5) Value-added products - Complete crop mask based on five years of inputs in order to account for inter-annual variability of crop cover. Start work on prototype development of Vegetation Moisture Stress Index using combination of VI and Land Surface Temperature (LST) data from the Rapid Response System. 6) Database management system - Add aggressive image and data caching techniques to improve system responsiveness. Add usability enhancements such as saving user search parameters/region browser default page/downloadable graph data/enhanced image zoom capabilities. Plan support for VIIRS.

FY06: Project may be extended to continue with transition from MODIS to VIIRS</td><td>Budget ($K)

Procurement

FY05 282

FY06 --
FY07 --
FY08 --
FY09 --</td></tr>
<tr><td>Project Manager</td><td>Centers</td><td>Timeframe</td><td>Partners</td></tr>
<tr><td>Chris Jusice/Matt Hansen</td><td>SSC, GSFC</td><td>FY03-FY05</td><td>USDA/FAS</td></tr>
<tr><td>Earth Science Products</td><td colspan="3">MODIS</td><td>Other Apps.</td></tr>
<tr><td>Deliverables</td><td colspan="3">Validation report(s), joint development plan, benchmark report(s), results conference(s)</td><td>N/A</td></tr>
</table>

<table>
<tr><td colspan="4">Project: USAID Agricultural Condition DST</td></tr>
<tr><td colspan="3">This project will integrate NASA global and regional climate models, TRMM precipitation data and MODIS vegetation data into a regional decision support system for land resource management, agriculture and climate in support of USAID programs and missions.

FY05 –Complete baseline report. Identify model input data sets, acquire historical NDVI/EVI data

FY06-beyond: Improved adaptation strategies for climate variability and change, at a regional scale, utilizing NASA missions and models and user crop models. Benchmark performance of regional DSS that aids decision making by agricultural stakeholders.</td><td>Budget ($K)

Procurement

FY05 100
FY06 500
FY07 500
FY08 300
FY09 --</td></tr>
<tr><td>Project Manager</td><td>Centers</td><td>Timeframe</td><td>Partners</td></tr>
<tr><td>Cynthia Rozensweig, GISS</td><td>GISS</td><td>FY05-FY08</td><td>USAID, USDA</td></tr>
<tr><td>Earth Science Products</td><td colspan="3">MODIS, TRMM, GISS RCM and MM5 models</td><td>Other Apps.</td></tr>
<tr><td>Deliverables</td><td colspan="3">Evaluation report(s), validation report(s), joint development plan, benchmark report(s), results conference(s)</td><td>N/A</td></tr>
</table>

Supporting projects and efforts to Agricultural Efficiency (no associated procurement funds):

- Goddard Space Flight Center: S. Kempler: "Integrating NASA Earth Sciences Enterprise Data into Global Agricultural Decision Support Systems" TRMM and MODIS products for Foreign Agriculture Service (REASoN CAN).
- University of Maryland: J. Townshend: "The Global Land Cover Facility" Extend MODIS products to U.S. Forest Service (REASoN CAN).
- Louisiana State University: R. Leonard: "Adapting and Validating Precision Technologies for Cotton Production in Mid-Southern United States"
- Mississippi State University: D. Shaw: "Extending Earth science based climate and weather predictions to local agriculture"
- Stennis Space Center: R. Mckellip: Evaluation of current and planned NASA observations and products for DSS; FAS, et al.
- Stennis Space Center: R. Mckellip: Validation and verification of products for FAS DSS.
- Stennis Space Center: R. Mckellip: Program planning and implementation.

B. Solicitations

Support for enhancement of the decision support tools in the FAS is the primary activity of the Agricultural Efficiency Program Element. Two major projects enhancing the PECAD/CADRE

DSS of FAS were awarded through competitive solicitations in FY03 and FY04 (see Section V.A.1). Enhancements to the DSS are being benchmarked in FY05. Additional projects in Agricultural Efficiency are anticipated through the Decisions solicitation in FY05.

C. Congressionally Directed Activities

There are no congressionally directed activities related to Agricultural Efficiency for FY05.

D. Program Management

The following are program management activities to support the Agricultural Efficiency program. These activities are managed at NASA-HQ:

- Participate in NASA/USDA Interagency Working Group: Manage working group activities on behalf of Earth-Sun System Division. Develop collaborative projects with USDA in Agricultural Efficiency. Review projects in all national application areas and make recommendations on sources for support funding, e.g., new joint solicitations, directed funding, etc.).
- NASA representative to the Focus Area Working Group on Agricultural Efficiency as part of the NASA/USDA interagency activities. Help identify collaborative projects that meet USDA and NASA programmatic objectives. The working group is managed by USDA.
- Participate in conferences and workshops to update the community on Agricultural Efficiency Program Element.

E. Additional Activities and Linkages

In general, the NASA Agricultural Efficiency Program Element follows program direction to emphasize linkages to the following activities:

The Crosscutting Solutions Program—The program consists of functional elements that contribute to all of the National Applications activities. The intention is to have the performance of these functions leverage accomplishments, and therefore the apparent resource investment, to the greatest extent possible into the National Applications partnerships. These functions are: Geoscience Standards and Interoperability, Human Capital Development, Integrated Benchmark Systems, and Solutions Networks. Examples of leveraged activities are:

- *The Earth-Sun System Gateway* is a "portal of portals" providing an access point through an Internet interface to all web-enabled NASA research results.
- *A Rapid Prototyping Center* is a proposed center at Stennis to support NASA and partners in testing and verification of Earth science results in decision support tools.
- *Transition from Research to Operations Network (R2O)* is a network that focuses on systematically transitioning the results of research to operational uses.
- *DEVELOP* is a student-based program for rapidly prototyping solutions for state and local applications and helping students develop capabilities related to applied Earth-Sun science.

NASA and Science Mission Directorate Priorities

- *Federal Enterprise Architecture (FEA)* is a business and performance-based framework to support cross-agency collaboration, transformation, and government-wide improvement.
- *The Global Information Grid (GIG)* is the first stage of a U.S. military global, high-bandwidth, Internet protocol-based communications network (a.k.a., 'the Internet in space').
- *The Joint Center for Satellite Data Assimilation (JCSDA)* is a multi-agency collaboration to accelerate and improve the quantitative use of research and operational observational spacecraft data in weather and climate prediction models. NOAA (NESDIS, NWS, OAR), NASA, Navy, Air Force, and NSF (through UCAR) collaborate in JCSDA.
- *Metis* is a visual modeling software tool for planning, developing, and analyzing agencies' enterprise architectures. The Applied Sciences Program is using Metis to identify possible linkages between observations, models, and decision support tools to support the IWGEO and NASA/NOAA R2O activities.
- *Observing System Simulation Experiments (OSSEs)* use simulated observations to assess the impacts of future observational spacecraft instruments on weather and climate prediction and provide opportunities to test new designs and methodologies for data gathering and assimilation.
- *Project Columbia* is a NASA-wide project to develop a new, fast supercomputer (using an integrated cluster of interconnected processor systems) to support the Agency's mission and science goals, including enhanced predictions of weather, climate, and natural hazards.

VI. Budget Fiscal Years 2005-2009

The following table lists the Agricultural Efficiency Program budget (procurement) for FY2005:

Program/Projects	FY05 Procurement Allocation
Agricultural Efficiency	
UMd products for FAS DSS	$282
USAID Ag condition DST	$100
Extend Earth science data and models to USDA	$55
Program committee support	$30
Total	$467

Appendix C lists program-wide budget allocations for FY2005-09.

VII. Schedule and Milestones

FY05:

- Benchmark improvements to PECAD/CADRE DSS using MODIS and TRMM products.
- V and V for MODIS, TRMM and reservoir height products
- Benchmark Ag20/20 products
- Evaluate potential contribution of observations from NASA exploratory missions (e.g., OCO, GPM, HYDROS) in agricultural DSS
- Second biannual NASA/USDA workshop on Applied Sciences Applications

FY06-09:

- Benchmark improvements in PECAD/CADRE DSS as appropriate
- Develop and run simulations of new observations (e.g. OCO, HYDROS, etc.) in agricultural DSS

VIII. Performance Measures

The Agricultural Efficiency Management Team uses performance measures to track progress, identify issues, evaluate projects, make adjustments, and establish results of the Program Element. The Program's Goals and Objectives (Section II) state what the program intends to achieve. These measures help monitor progress within and across specific activities to ensure the program meets its goals and objectives. The management team analyzes these measures retrospectively in order to made adjustments proscriptively to the program approach and objectives.

The measures are in two categories. Program Management measures are internally focused to assess the activities within the program. Performance measures are externally focused to assess if the program activities are serving their intended purpose. In general, the program manager uses these measures to evaluate the performance of activities conducted and sponsored by the

program, especially the projects. In addition, the Earth-Sun System Division's Applied Sciences Program uses this information in preparing IBPD directions and PART responses.

Program Management Measures (Internal):

Inputs	Potential issues and DSTs identified for agricultural efficiency – *number, type, range* Eligible partners to collaborate with – *number, type, range* Potential results/products identified to serve agricultural efficiency – *number, type, range*
Outputs	Assessments or evaluations of DSTs – *number, range* Assessments of Earth-Sun science results/products to serve DSTs – *number, range* Agreements with partners – *presence* Reports (evaluation, validation, benchmark) – *number, type*
Quality and Efficiency	Earth-Sun science results/products – *number used per DST, ratio of utilized to potential* Agreements – *ratio of agreements to committed partners* Reports – *partner satisfaction, timeliness, time to develop* Reports – *ratio of validations to potential products, ratio of benchmarks to validations*

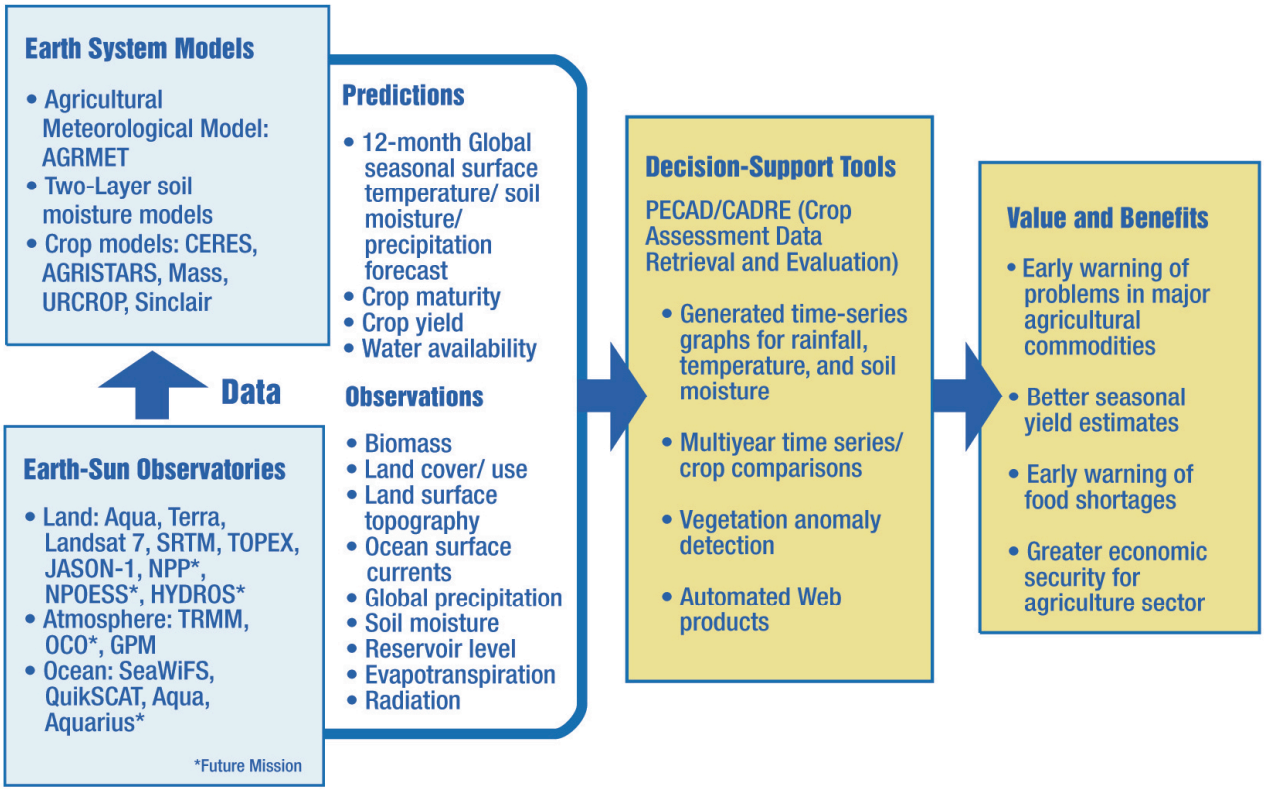
Performance and Results Measures (External):

Outcomes	Applied Sciences products adopted in DSTs – *number, type, range; use in DST over time* Earth-Sun science products in use – *ratio of products used by partners to reports produced* Partner & DST performance – *change in partner DST performance, number and type of public recognition of use & value of Earth-Sun science observations in DST*
Impacts	Partner value – *change in partner metrics (improvements in value of partner decisions)*

In addition to the stated measures, the Agricultural Efficiency Program Element manager periodically requests an assessment of plans, goals, priorities, and activities through external review. The Agricultural Efficiency Program Element team uses these measures along with comparisons to programmatic benchmarks to support assessments of the Earth-Sun Division Applied Sciences Program (e.g. internal NASA reviews and OMB PART).

IX. Appendices:

Appendix A. Integrated System Solutions Diagram



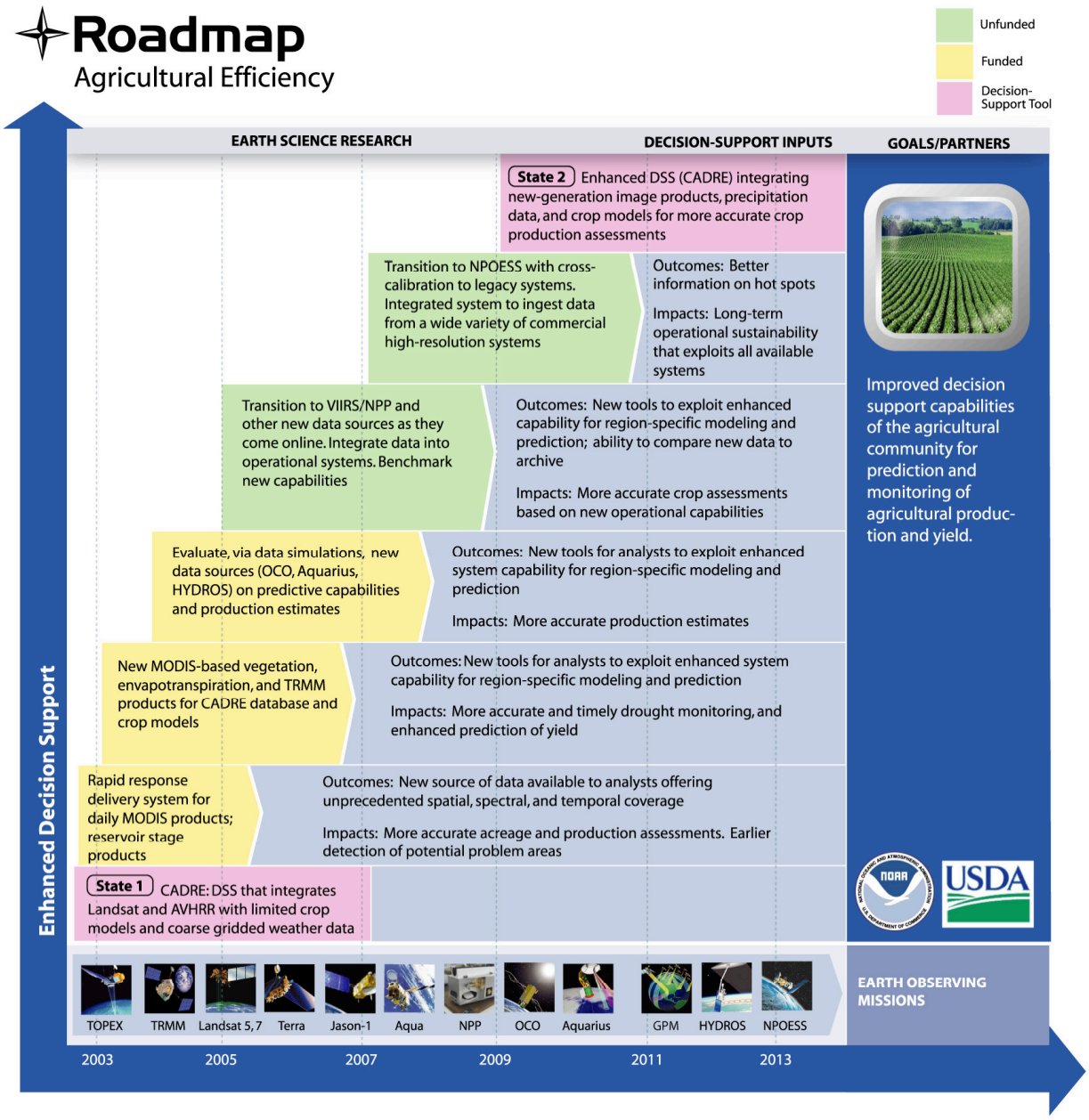
Appendix B. Roadmap

The Agricultural Efficiency roadmap illustrates how NASA capabilities in Earth observation, measurement, modeling and systems engineering are exploited systematically to improve the decision support systems and tools of USDA and other agencies and organizations making policy and resource decisions for agriculture. The roadmap focuses on USDA, base-lining current capabilities and benchmarking improvements as such improvements are integrated into USDA's operational procedures.

The primary activity in FY04 is the integration and evaluation of MODIS, TRMM, Topex/Poseidon and Jason-1 products. Beginning in FY05 and continuing in the out years, data from new systems will be evaluated, initially through simulations, then through analysis of the data when available.

Several planned NASA Earth-Sun science missions have the potential to impact USDA decision support tools and systems. These missions include Orbiting Carbon Observatory (OCO), Aquarius and HYDROS. The OCO provides space-based observations of atmospheric carbon dioxide (CO2), the principal anthropogenic driver of climate change. This mission uses mature technologies to address NASA's highest priority carbon cycle measurement requirement. OCO generates the knowledge needed to improve projections of future atmospheric CO2. Aquarius is a focused spacecraft mission to measure global sea surface salinity (SSS). Aquarius will resolve missing physical processes that link the water cycle, the climate, and the ocean. The Aquarius science goals are to observe and model the processes that relate salinity variations to climatic changes in the global cycling of water and to understand how these variations influence the general ocean circulation. The HYDROS mission will provide the first *global* views of Earth's changing soil moisture and land surface freeze/thaw conditions, leading to breakthroughs in weather and climate prediction and in the understanding of processes linking water, energy, and carbon cycles.

The Roadmap shows the major events in the chronology toward evaluation of these sources of data and information and the progression of the data toward improved decision support systems and tools over the next ten years.


Roadmap
Agricultural Efficiency
Unfunded
Funded
Decision-Support Tool
EARTH SCIENCE RESEARCH
DECISION-SUPPORT INPUTS
GOALS/PARTNERS
State 2 Enhanced DSS (CADRE) integrating new-generation image products, precipitation data, and crop models for more accurate crop production assessments
Transition to NPOESS with cross-calibration to legacy systems. Integrated system to ingest data from a wide variety of commercial high-resolution systems
Outcomes: Better information on hot spots
Impacts: Long-term operational sustainability that exploits all available systems
Transition to VIIRS/NPP and other new data sources as they come online. Integrate data into operational systems. Benchmark new capabilities
Outcomes: New tools to exploit enhanced capability for region-specific modeling and prediction; ability to compare new data to archive
Impacts: More accurate crop assessments based on new operational capabilities
Evaluate, via data simulations, new data sources (OCO, Aquarius, HYDROS) on predictive capabilities and production estimates
Outcomes: New tools for analysts to exploit enhanced system capability for region-specific modeling and prediction
Impacts: More accurate production estimates
New MODIS-based vegetation, envapotranspiration, and TRMM products for CADRE database and crop models
Outcomes: New tools for analysts to exploit enhanced system capability for region-specific modeling and prediction
Impacts: More accurate and timely drought monitoring, and enhanced prediction of yield
Rapid response delivery system for daily MODIS products; reservoir stage products
Outcomes: New source of data available to analysts offering unprecedented spatial, spectral, and temporal coverage
Impacts: More accurate acreage and production assessments. Earlier detection of potential problem areas
State 1 CADRE: DSS that integrates Landsat and AVHRR with limited crop models and coarse gridded weather data
Improved decision support capabilities of the agricultural community for prediction and monitoring of agricultural production and yield.
NOAA
USDA
Enhanced Decision Support
TOPEX
TRMM
Landsat 5, 7
Terra
Jason-1
Aqua
NPP
OCO
Aquarius
GPM
HYDROS
NPOESS
EARTH OBSERVING MISSIONS
2003
2005
2007
2009
2011
2013

Appendix C. Applied Sciences Program Budget FY2005

The overall program budget allocations are given below to provide the context in which this National Application is conducted. The allocations are based on Agency and program priorities and are subject to change according to the availability of funds and programmatic strategies. All values are in $ thousands.

*NOTE: Allocations include full utilization of the Applied Sciences FY04 carryover of approximately $2.7 million.

Table 1: Applied Sciences Procurement Allocation – FY05

Program Element	FY05 Procurement Allocation
National Applications	
Agricultural Efficiency	$ 467
Air Quality Management	$ 995
Aviation	$ 750
Carbon Management	$ 653
Coastal Management	$ 550
Disaster Management	$ 545
SENH	$ 1,429
Ecological Forecasting	$ 610
Energy Management	$ 775
Homeland Security	$ 205
Invasive Species	$ 205
Public Health	$ 725
Water Management	$ 870
Program Director Discretionary Fund	$ 588
Center Director Discretionary Fund Tax	$ 2,485
National Applications Total	$ 11,852
Crosscutting Solutions	
Integrated Benchmarked Systems	$ 3,529
Solutions Networks	$ 1,200
Competitive Solicitations	$ 7,600
Human Capital Development	$ 700
Geoscience Standards & Interoperability	$ 2,000
Crosscutting Solutions Total	$ 15,029
Applied Sciences Program Procurement Total	***$ 26,881***

Table 2: Applied Sciences Program NASA Institutional Allocations – FY05

NASA Center	FY05 Institutional Cost / National Applications	FY05 Institutional Cost / Crosscutting Solutions	Institutional Total
HQ	$3,773	$7,351	$11,124
ARC	$1,108		$1,108
GSFC	$1,009	$1,094	$2,103
JPL			
LaRC	$1,517	$444	$1,961
MSFC	$1,251	$183	$1,434
SSC	$3,194	$8,689	$11,883
Total	**$11,852**	**$17,761**	**$29,613**

Appendix D. Related NASA and Partner Solicitations and Grants

1. Fellowships: NASA Fellowships for the period 2002 through 2006 with potential impact on the Agricultural Efficiency Program:

Name	Institution	Title
Luz Maria Cisneros Dozal	University of California, Irvine	Quantifying Sources of Soil Respiration and Their Response to Environmental Changes
Desheng Liu	University of California, Berkeley	Systematic Evaluation of Machine Learning Approaches for Remote Sensing Land Cover Classification
Virginia Matzek	Stanford University	Plant Nutrients, Beyond N and P: How Will Plant Growth Rates, Leaf Traits, and Tissue Chemistry Respond to the Altered Stoichiometry of Anthropogenic Global Change?
Weile Wang	Boston University	Tracing Causality and Feedback Relations between Land Surface Temperatures and Vegetation Activity in Twenty-Years of Remote Sensing Data
Mekonnen Woldemaria	University of Iowa	Characterization of the Spatial Variability of Rainfall from Remote Sensing

2. Interdisciplinary Studies and EOS awards with potential impact on Agricultural Efficiency:

Name	Institution	Title
Robert Dickinson	Georgia Tech.	Using MODIS Data to Characterize Climate Model Land Surface Processes and the Impacts of Land Use/Cover Change on Surface Hydrological Processes
Jonathan Foley	University of Wisconsin	Agricultural Land use and the Transformation of Planet Earth: Investigating the Effects of Land use Practices on the Ecological, Biogeochemical and Hydrological Systems of the Planet
Thomas Loveland	US Geological Survey	The Influence of Historical and Projected Land use and Land Cover Changes on Land Surface Hydrology and regional Weather and Climate Variability
Gary Peterson	Pennsylvania State University	Applying MODIS Parameters for Crop Yield Modeling

Appendix E. Acronyms and Websites

Acronyms

AgriSTARS	Agriculture and Resources Inventory Surveys through Aerospace Remote Sensing
AIS	Agricultural Information System
AIWG	Applications Implementation Working Group
Aqua	Earth Observing Systems spacecraft
Aquarius	Mission to measure global Sea Surface Salinity
AVHRR	Advanced Very High Resolution Radiometer
CADRE	Crop Assessment Data Retrieval and Evaluation
CCSP	Climate Change Science Program
CCTP	Climate Change Technology Program
CO_2	Carbon Dioxide
COTR	Contracting Officer's Technical Representative
DAAC	Distributed Active Archive Center (Data Active Archive Center)
DEVELOP	No longer an acronym
DSI	Disease Severity Index
DSS	Decision Support Systems
DST	Decision Support Tool
ESA	Earth Science Applications
ESG	Earth-Sun System Gateway
EVI	Enhanced Vegetation Index
FAS	Foreign Agricultural Service
FEA	Federal Enterprise Architecture
FSA	Farm Service Agency
FY	Fiscal Year
GES	Goddard Earth Sciences
GIG	Global Information Grid
GISS	Goddard Institute for Space Studies
GPM	Global Precipitation Measurement
GRI	Global Reporting Initiative/Geospatial Research Institute
GSFC	Goddard Space Flight Center
GSI	Geoscience Standards and Interoperability
Hydros	Hydrosphere State Mission
IBPD	Integrated Budget and Performance Document
JCSDA	Joint Center for Satellite Data Assimilation
LACIE	Large Area Crop Inventory Experiment
LST	Land Surface Temperature
MODIS	Moderate Resolution Imaging Spectroradiometer
MOU	Memorandum of Understanding
NACP	North American Carbon Program
NASA HQ	NASA Headquarters
NASA	National Aeronautics and Space Administration
NASS	National Agriculture Statistics Service
NBARS	Nadir BRDF Adjusted Reflectance (from MODIS)
NESDIS	National Environmental Satellite Data Information Service
NOAA	National Oceanic and Atmospheric Administration
NRA	NASA Research Announcement

NRCS	National resource Conservation Service
NSF	National Science Foundation
NWS	National Weather Service
OAR	Office of Oceanic and Atmospheric Research
OCO	Orbiting Carbon Observatory
OMB	Office of Management and Budget
OSSE	Observing System Simulation Experiment
OSTP	Office of Science and Technology Policy
PART	Program Assessment Rating Tool
PECAD	Production Estimates and Crop Assessment Division
R2O	Research to Operations Network
REASoN	Research, Education, and Applications Solutions Network
RMA	Risk Management Agency
SEA	State Enterprise Architecture
SMI	Surface Moisture Index
SPOT	French Satellite which Collects Information on Arousals and Ozone
SSC	Stennis Space Center
SSS	Sea, Surface, Salinity
Terra	Not an Acronym
TOVAS	TRMM Online Visualization and Analysis System
TRMM	Tropical Rainfall Measurement Mission
UCAR	University Corporation for Atmospheric Research
USAID	United States Agency for International Development
USDA	US Department of Agriculture
V&V	Verification and Validation
VI	Vegetation Index
VIIRS	Visible/Infrared Imager/Radiometer Suite
WAOB	World Agricultural Outlook board
WFP	World Food Program

Websites

AIWG: http://aiwg.gsfc.nasa.gov/

Applied Sciences Program: http://science.hq.nasa.gov/earth-sun/applications

DEVELOP: http://develop.larc.nasa.gov

Earth-Sun System Gateway (ESG): http://esg.gsfc.nasa.gov/

Earth-Sun Science System Components: http://www.asd.ssc.nasa.gov/m2m

NASA FY2005 Budget: http://www.ifmp.nasa.gov/codeb/budget2005

Research and Analysis Program: http://science.hq.nasa.gov/earth-sun/science/

Science Mission Directorate: http://science.hq.nasa.gov

Science Strategies: http://science.hq.nasa.gov/strategy/